SECTION C - INLET STRUCTURE

Contents | Page

Figures

SECTION C - INLET STRUCTURE

I. INTRODUCTION

Innumerable varieties of inlet structures are designed individually for essentially the same conditions and requirements. The standard structure in this section has evolved over a period of years and incorporates details based on experience gained from a number of installations. This structure is for use with a 3:1 upstream embankment slope.

Two trash rack systems are given: one, more suitable for low head installation, and the other for higher heads where portions of the rack may need to be removed for maintenance without the use of heavy duty lifting equipment.

A single miter elbow has been selected in preference to a multiple miter. Savings in head due to the improved hydraulics of the multiple miter elbow does not justify the additional cost of fabrication.

II. GENERAL CRITERIA

The standard inlet was designed using Class 3000 concrete with an allowable stress of $0.45\ f'_c$. If Class 4000 concrete is required, no change in detail is necessary other than to call for the higher strength concrete in the specifications. Intermediate grade steel was used with an allowable working stress f_s = 20,000 psi.

Reference is made to the following specifications (not included in the manual) as they affect the gate details:

a. Construction Specification Nos. 71, 81.
b. Materials Specification Nos. 553, 571, 572, 573, 581, 582.

III. NOMENCLATURE AND GENERAL NOTES

Components of the rising and non-rising stem type gates are schematically illustrated in Figure C-1.

Non-rising stems have limited application to Service use. Their main use is for installations where straight stem alignment is not possible. A universal joint transmits torsional forces at a slope change that prohibits the use of a rising stem.

Of the four types of gate seat backs, the one most used in the Service is the spigot back. It is cast directly in the concrete or grouted into place, and anchored by preset bolts. It may also be connected directly to steel pipe. The spigot back is limited in availability to the low and medium duty gate. Not all manufacturers supply this type.

The flange back gate resists warping better than the spigot back. It is used to advantage in mounting on existing walls. For larger, heavy duty gates, this type is used with a thimble previously cast in the receiving wall.

The flange and spigot back gate seat is used primarily where top and bottom wedges are required and the gate cast directly in a concrete structure.

The flat back gate seat should be used with a thimble. A thin coat of fibrated mastic should be placed between the contact surfaces.

The gate seat opening may vary with class of gate. For light duty the gate seat opening may be circular. For heavier duty gates the seat may have a rectangular opening but the gate frame will reduce to a circular opening. A rectangular opening is used with special seat facings (usually bronze).

Bronze seat facings are recommended even with light duty gates. At the time of final adjustment a light application of waterproof grease should be applied to the seat faces.

Some leakage can be expected: the maximum should not exceed 0.2 gpm per foot of periphery at a face pressure equal to 16 ft of water.

IV. STANDARD INLET

A. Structure Size

Dimensions of the standardized inlet are tabulated on Figure C-2. The size of the inlet is directly related to the conduit diameter and is the same regardless of the head. Dimension (4) will require adjustment when pipe diameters other than those listed in the tabulation are used. This adjustment is required to keep the rest of the dimensions constant for each structure size. Structure dimensions pertain to an embankment slope of 3:1. A typical standard drawing (size H - 21" conduit) is shown on Figure H-3 of the completed example.

Inlet structure size J (36" conduit) will require change if hydraulic controls are used with the cylinder mounted at the gate. Discussion of controls will be found in Section D.

B. Trash Rack

Standard drawings for trash racks have not been developed because of the wide range in structure size and head. Two alternate systems of trash racks are presented with details and member sizes for each. Both alternates provide for a double cross bar to reduce longitudinal member sizes for the higher heads.

1. Figure C-2 contains details for trash racks welded into one unit. This construction is recommended for the lower head systems where the total rack weight would not exceed the ability of two men to set the rack in place.

2. Figure C-3 provides details for the alternate rack system. For the larger conduit sizes or higher heads, the rack may be assembled one longitudinal member at a time. This figure must be used with Figure C-2 for completing details.

C. Inlet Protection

Where the soil surrounding the inlet structure is fine grained with low plasticity, protection should be provided on both the slope and the level approach area. Size of rock and extent of protection from conduit centerline is given in Figure C-4. This figure was developed from the procedure presented in SCS Technical Release No. 3.

V. VENT PIPE

Vent pipes are recommended for all gated outlets provided flow meters are not to be used in the conduit. Vents were discussed previously in Section B, Hydraulics. The hydraulic analysis as a result of venting does not lend itself to exact analysis. The net effect of a vent is to reduce discharge capacity for the free flow outlet condition; the inlet control capacity will be minimum.

Recommended vent pipe diameters are shown in Figure C-5. The vent pipe size is based on a maximum air velocity of 100 fps and necessarily requires an increase in vent diameter with hydraulic head. A point of interest, maximum air demand occurs with a partial gate opening.

Three dashed lines curving upward to the right represent three fixed ratios of vent sizes called for by some manufacturers under various conditions. These lines have been added for comparison only.

A word of caution--if the installation involves an extended pipeline with outlet control, an oversized vent will result from use of Figure C-5 without modification.

If the outlet pipeline is extended beyond the toe of the embankment and outlet control exists, the vent pipe may be reduced from that given directly on Figure C-5. Explanation of this difference is based on the fact that the standard dam was used in developing many of the design aids. With an extended pipeline the additional friction losses reduce the carrying capacity of the system, thereby reducing the velocity and vent size requirement. The required vent size for the longer pipeline can be readily found by converting the proposed system to an equivalent standard dam (for calculation purposes only) and selecting the vent size accordingly. The following example should illustrate the principle involved.

A standard dam with a 20 inch conduit (n = 0.011) outletting at the toe of the embankment will carry 40 cfs at a 16 ft. head, see Figure B-1, and require a 1.5 inch vent pipe, see Figure C-5. If the pipeline was extended another 100 ft. (L = 170 ft.) beyond the embankment the discharge for the same head would be reduced to 35 cfs, see Figure B-6, because of the additional friction loss. The 20 inch conduit diameter with a lesser discharge is the same as a standard dam with a head of 11 feet, see Figure B-1. With this lesser equivalent head the vent pipe diameter can be reduced from 1.5 inches to 1.25 inches, from Figure C-5.

VI. QUANTITY SURVEY

Concrete and reinforcing steel quantities are listed on Figure C-2. A refinement of these quantities based on conduit type and additional diameters is given in Table J-C1.

VII. EXAMPLE

<u>Given</u>: Continuing the earth dam problem from Section B.

<u>Determine</u>: Type of gate back, size of trash rack members, diameter of vent pipe, extent of inlet protection and reinforced concrete quantities.

<u>Problem Analysis</u>:

1. Find size of standard inlet to be used and its drawing number.

2. Find size of trash rack members.

3. Select other construction details and scale appropriate to reproduction method.

4. Determine need for rock protection at inlet and size of rock and filter required.

5. Determine size of vent pipe required.

6. Find material quantities for the inlet.

Solution: A spigot back gate is available in all three conduit sizes. This gate will be attached to the conduit, located on the proper slope and elevation, and inlet concrete placed.

Referring to Figure C-2, it can be seen that the structure size for the 20 inch conduit should be a size G; a size H will be used for the 21 inch and 24 inch conduits. Find the following items from the referenced figures.

1. Standard Drawings (from Figure C-2)

20" conduit	7-N-20465G
21" and 24" conduits	7-N-20465H

2. Size of trash rack members - Using a single cross bar because of the low head on the inlet, the following may be found from C-2.

Inlet	Trash Rack Member			
	Longitudinal	Cross Bar A	Cross Bar B	Z
G-1	1 1/2" pipe	4" x 3/8"	4" x 1/2"	4"
H-1	2" pipe	4" x 3/8"	4 I 9.5	4"

3. Construction details - Trash rack details are found on Figure C-2. Note that the lettering on these details is of a size and weight consistent with construction drawing requirements and a duplicate figure could be cut up and used in making a mosaic as explained in Section H, Drawing Layout and Summary.

4. Inlet protection - Recommended inlet protection is found on Figure C-5.

Conduit size	Rock size d_{75}	Filter thickness	R
20 W.S.	9"	5"	4'
21 R/C	9 1/2"	5"	4'
24 CMP	7 1/2"	4"	4'

This protection should be provided if the soil adjacent to the inlet is fine grained material of low plasticity.

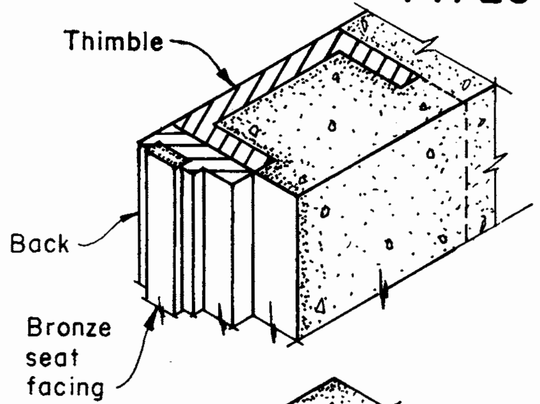
5. Vent pipe - A 2" vent pipe, as obtained from Figure C-5, is recommended for all three outlet conduits.

6. Reinforced Concrete Quantities (from Table J-C1)

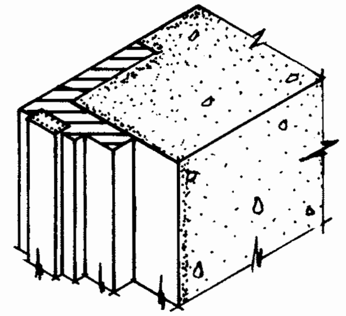
Conduit size	Type	Concrete, cu yds	Reinforcing, lbs
20"	Steel	3.4	209
21"	R/C	5.9	302
24"	CMP	4.7	302

7. Hydraulic control - If the hydraulic control alternate (discussed in Section D) is used, no modification of the standard inlet structure (except size J) is required other than to indicate embedded anchor bolts for the appropriate cylinder mount selected.

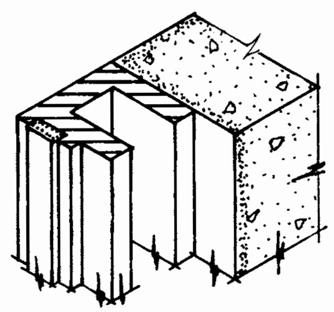
TYPES OF GATE FRAME BACKS



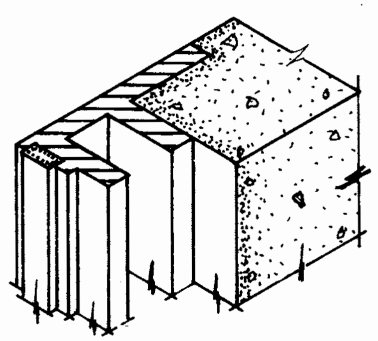
FLAT BACK Shown mounted on "U" thimble set in concrete wall. Anchor bolts are not required. This type of back may be mounted directly to the concrete surface or bolted to a pipe flange.



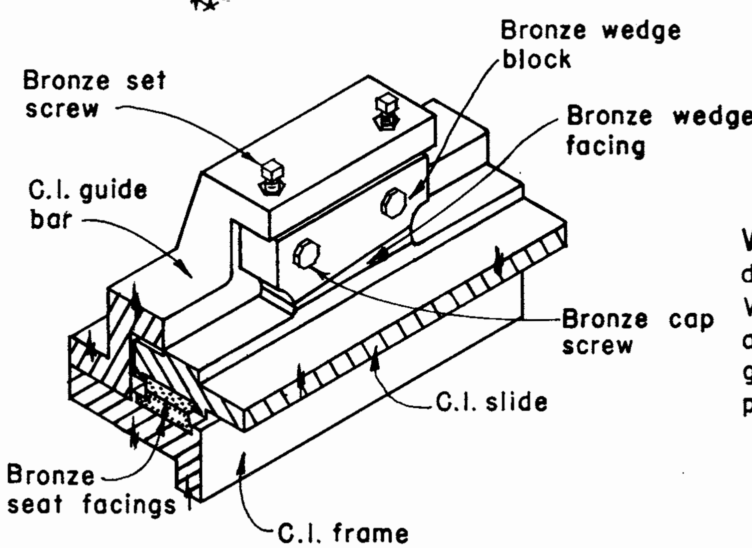
SPIGOT BACK Shown cast in place in a concrete structure. This type of back may also be grouted into place if proper recesses are provided. This type of back is also used when mounting a metal conduit.



FLANGE BACK Shown mounted directly on a concrete face. This type of back is used on gates operating at higher heads and may require a thimble mount.

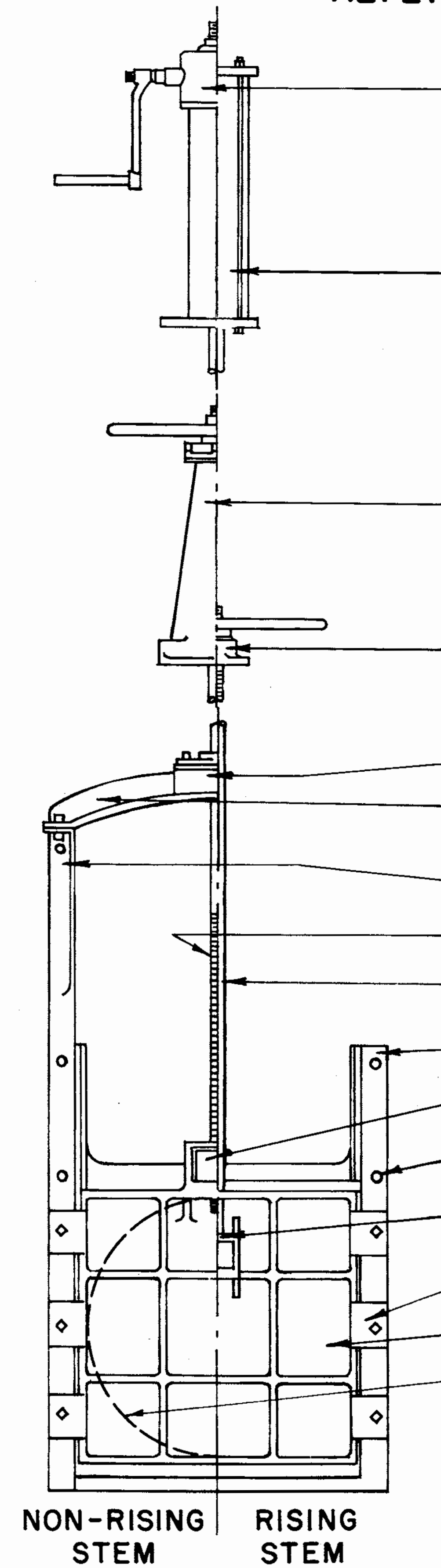


FLANGE AND SPIGOT BACK Shown cast in place in a concrete structure. This type of back is used on gates operating at higher heads.



WEDGE BLOCK Used in developing a watertight gate seal. Wedge blocks will also be located at top and bottom of gate if gate is subjected to unseating pressure.

ALTERNATE LIFT DETAILS



ENCASED GEAR PEDESTAL LIFT This type of lift is required for a larger gate or higher head combination.

HYDRAULIC CYLINDER LIFT This type of lift is ordinarily mounted on a gate yoke but can be mounted on the concrete surface in which the gate is set. The pump and valve for this lift may be located at the top of the embankment or at some other remote location not aligned with the gate axis.

PEDESTAL BASE HANDWHEEL LIFT This type of lift is normally used in a vertical position on an operating deck to raise the control wheel within reach of the operator.

HANDWHEEL LIFT This type of lift is similar to the pedestal base lif, except it is mounted on an extension of the gate frame or onto an integral part of the structure.

THRUST BEARING

YOKE Alternate hydraulic cylinder location in place of thrust bearing and non-rising stem.

GATE FRAME Extend to support yoke.

STEM Non rising, threaded at gate.

STEM Rising, threaded at lift

GATE FRAME

STEM BLOCK

ANCHOR BOLT

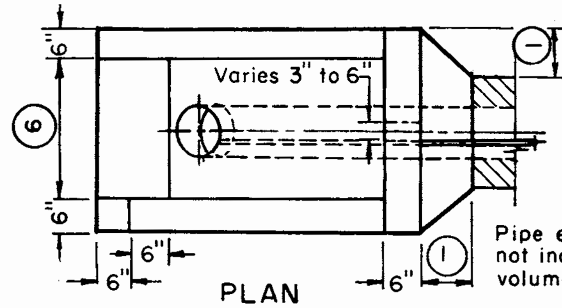
STEM BLOCK

WEDGE BLOCK

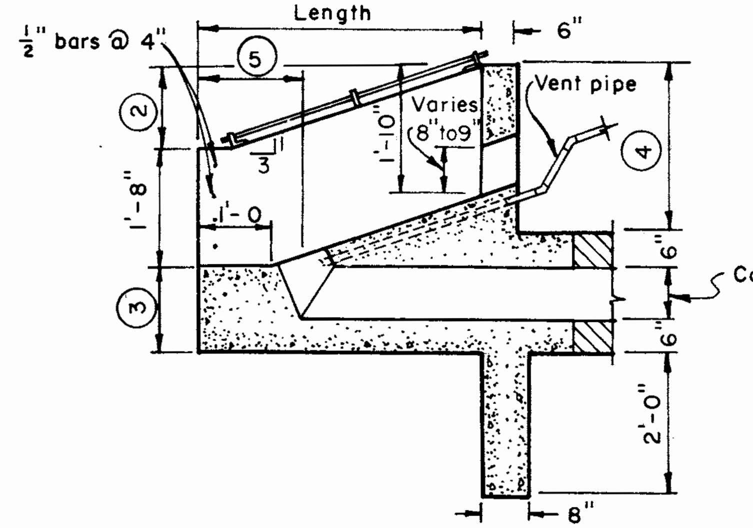
GATE SLIDE

SEATING SURFACE Circular or rectangular opening

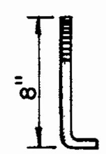
FIGURE C-1
NOMENCLATURE
WATER CONTROL GATE
EWP Unit Portland, Oregon



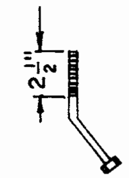
PLAN



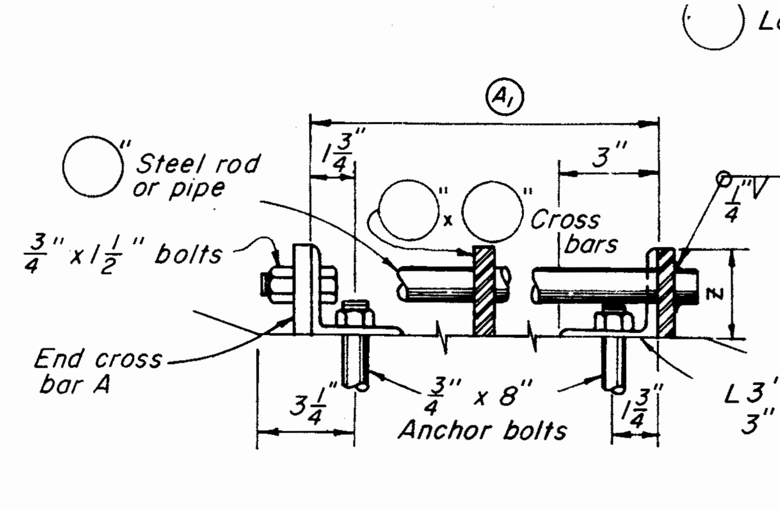
SECTIONAL ELEVATION



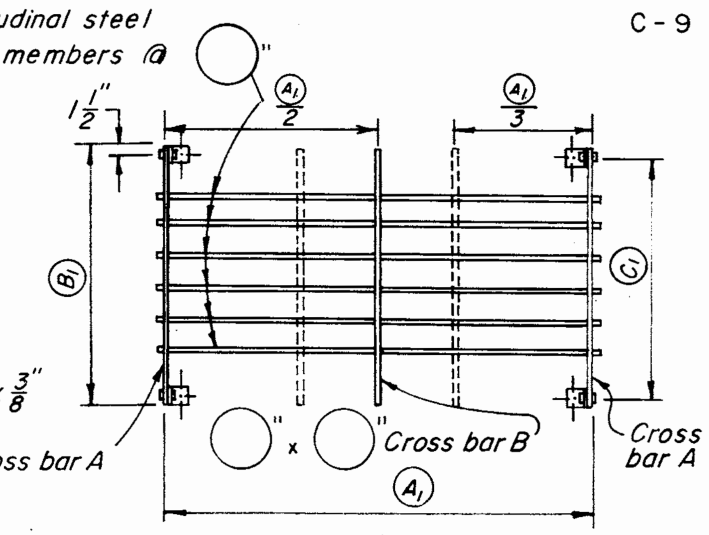
ANCHOR BOLT



ALT. ANCHOR BOLT



DETAILS



PLAN

Note:
When one intermediate bar is used place at center.
When two intermediate bars are used space at $\frac{A_1}{3}$.

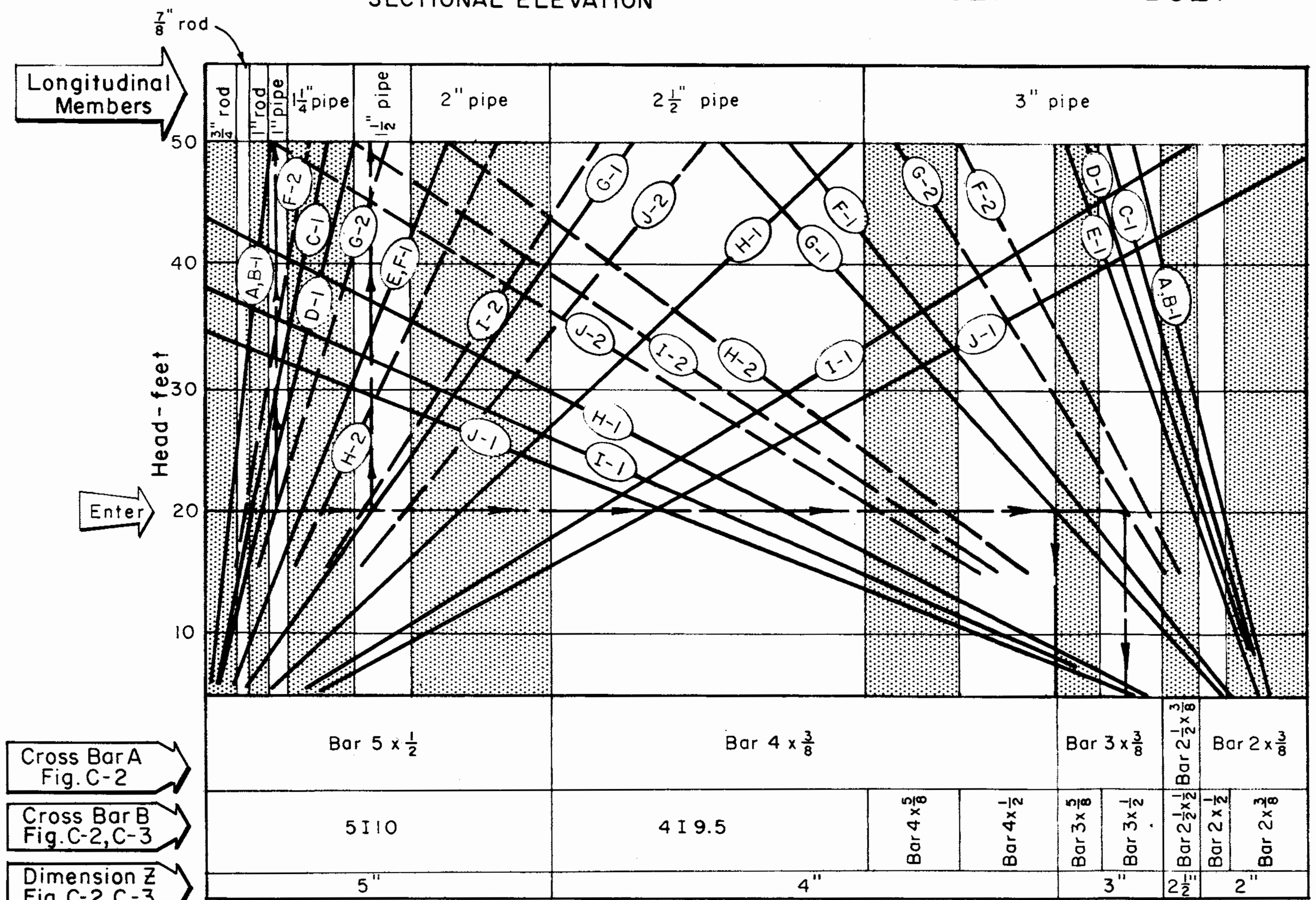
TRASH RACK

Not to Scale

Structure / Conduit Size / ITEM	A	B	C	D	E	F	G	H	I	J
	8"	10"	12"	14"	16"	18"	20"	24"	30"	36"
1	8"	7"	6"	5"	4"	9"	8"	1'-0"	9"	6"
2	1'-2"	1'-2"	1'-4"	1'-6"	1'-8"	1'-8"	2'-0"	2'-6"	2'-10"	3'-0"
3	1'-2"	1'-2"	1'-6"	1'-8"	1'-8"	2'-0"	2'-0"	2'-6"	2'-6"	3'-0"
† 4 (Varies)	2'-4"	2'-2"	2'-6"	2'-8"	2'-8"	2'-10"	3'-0"	3'-8"	3'-6"	3'-8"
5	1'-6"	1'-7"	1'-9"	1'-10"	2'-0"	2'-0"	2'-2"	2'-2"	2'-4"	2'-10"
6	2'-0"	2'-0"	2'-0"	2'-0"	2'-0"	3'-0"	3'-0"	4'-0"	4'-0"	4'-0"
LENGTH	4'-0"	4'-0"	4'-6"	5'-0"	5'-6"	5'-6"	6'-6"	8'-0"	9'-0"	9'-6"
TRASH RACK A_1	3'-5$\frac{1}{4}$"	3'-5$\frac{1}{4}$"	3'-11$\frac{1}{2}$"	4'-6"	5'-0$\frac{1}{4}$"	5'-0$\frac{1}{4}$"	6'-1"	7'-7$\frac{3}{4}$"	8'-8$\frac{1}{2}$"	9'-2$\frac{3}{4}$"
TRASH RACK B_1	2'-9"	2'-9"	2'-9"	2'-9"	2'-9"	3'-9"	3'-9"	4'-9"	4'-9"	4'-9"
TRASH RACK C_1	2'-6"	2'-6"	2'-6"	2'-6"	2'-6"	3'-6"	3'-6"	4'-6"	4'-6"	4'-6"
TRASH RACK BAR SPACING	4" c-c	4" c-c	6" c-c	6" c-c	8" c-c	9" c-c	10" c-c	10" c-c	12" c-c	12" c-c
⊛ VOL. CONC. C.Y.	1.33	1.32	1.57	1.84	1.97	2.91	3.40	4.72	6.52	7.00
REIN. STEEL	109#	108#	127#	129#	144#	174#	209#	302#	328#	366#
STD. DWG. NO.	7-N-20465 (Suffixed by size letter) 2 sheets per each structure size									

⊛ Volume of concrete using C.M.P. or steel pipe. See Table J-C1 for volumes using other types and sizes of pipe.

† If pipe diameter is different from that tabulated adjust dimension 4 to keep the total height of the inlet constant. (See discussion Section C-IV-A)



See AISC Steel Construction Manual for Nomenclature

Example

Given: Structure size G
Head = 20 feet

Find: With one intermediate cross bar use line (G-1)
Longitudinal member = $1\frac{1}{2}$" pipe
Cross bar A = 4" x $\frac{3}{8}$"; Cross bar B = 4" x $\frac{1}{2}$"
Z = 4"
With two intermediate cross bars use line (G-2)
Longitudinal member = 1" pipe
Cross bar A = 3" x $\frac{3}{8}$"; Two cross bars B = 3" x $\frac{1}{2}$"
Z = 3"

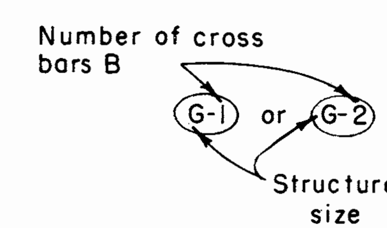
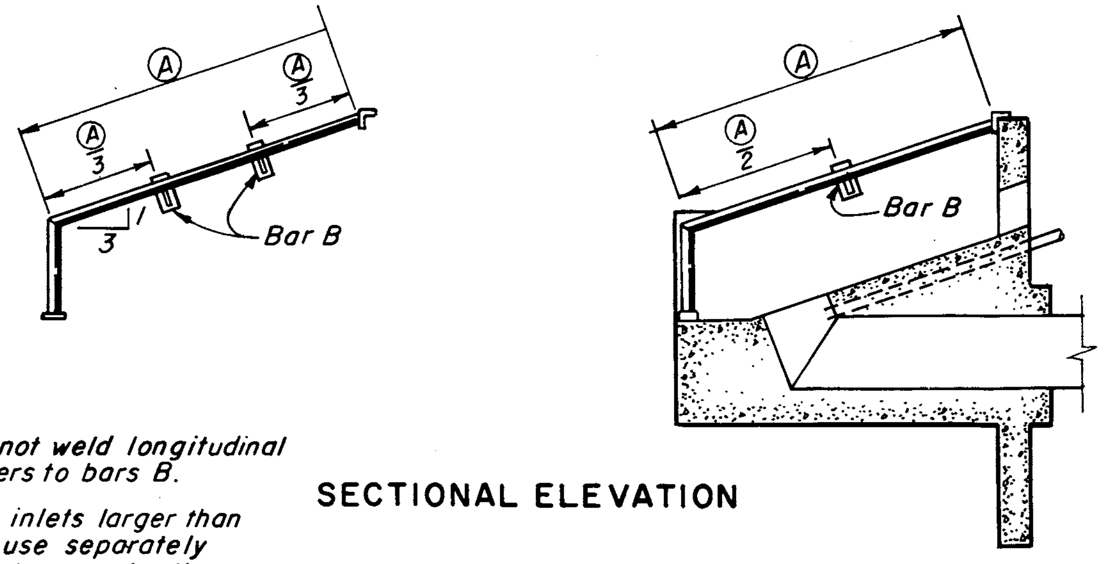


FIGURE C-2

INLET STRUCTURE

EWP Unit Portland, Oregon



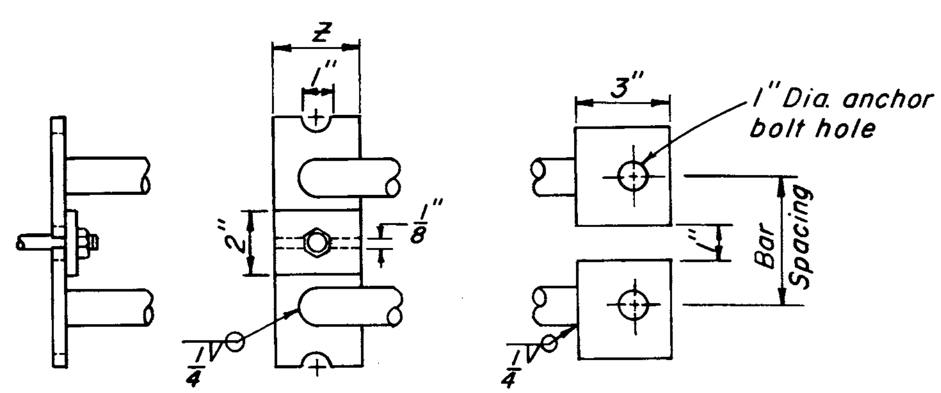
Note:
Do not weld longitudinal members to bars B.
*For inlets larger than size E use separately removable longitudinal members.

SECTIONAL ELEVATION

PLAN

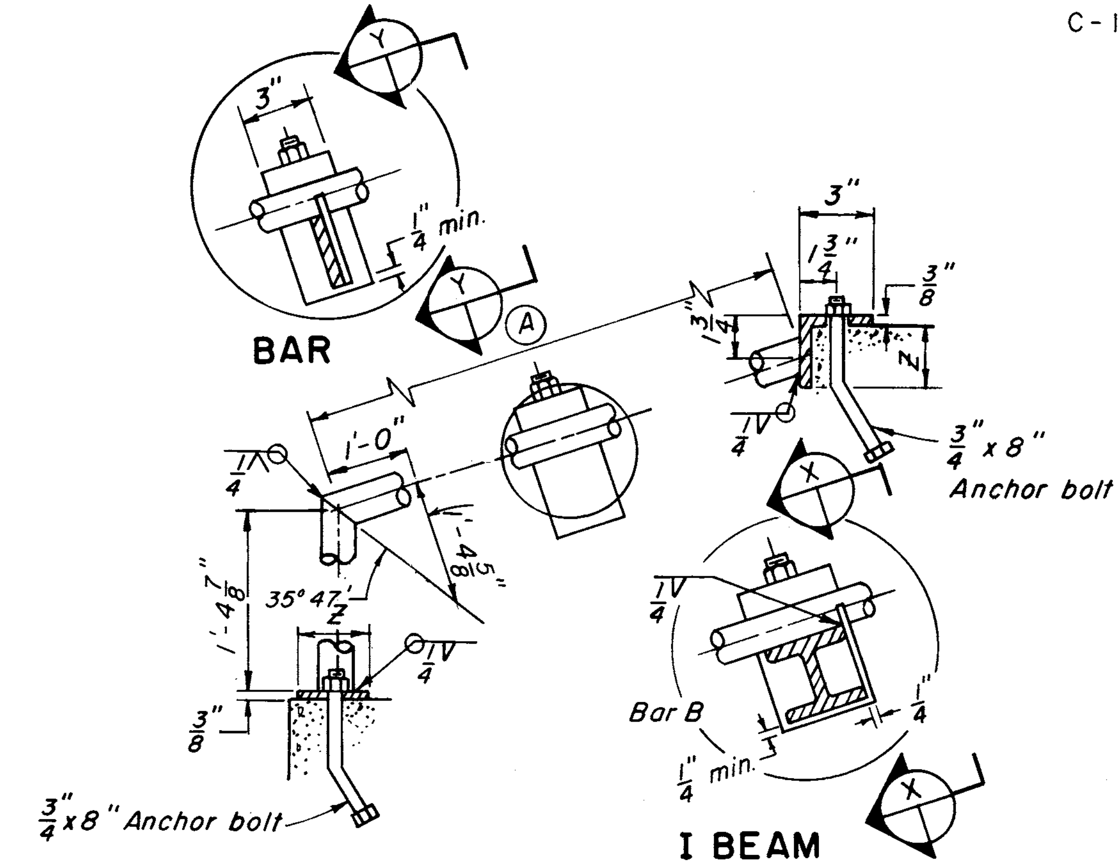
Two Cross Bars

One Cross Bar

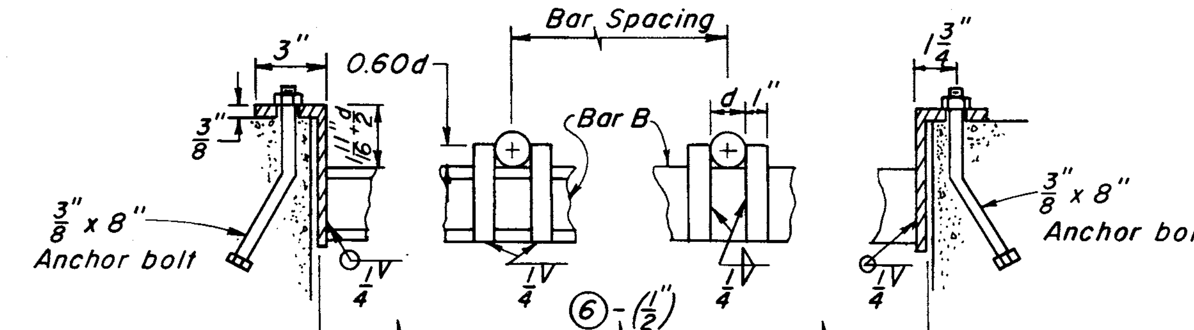


END FASTENING DETAILS FOR "F" SIZE AND ABOVE STRUCTURES

TRASH RACK FASTENING DETAILS



TRASH RACK FASTENING DETAILS



SECTION X

SECTION Y

See Figure C-2 for dimensions not given on this figure.

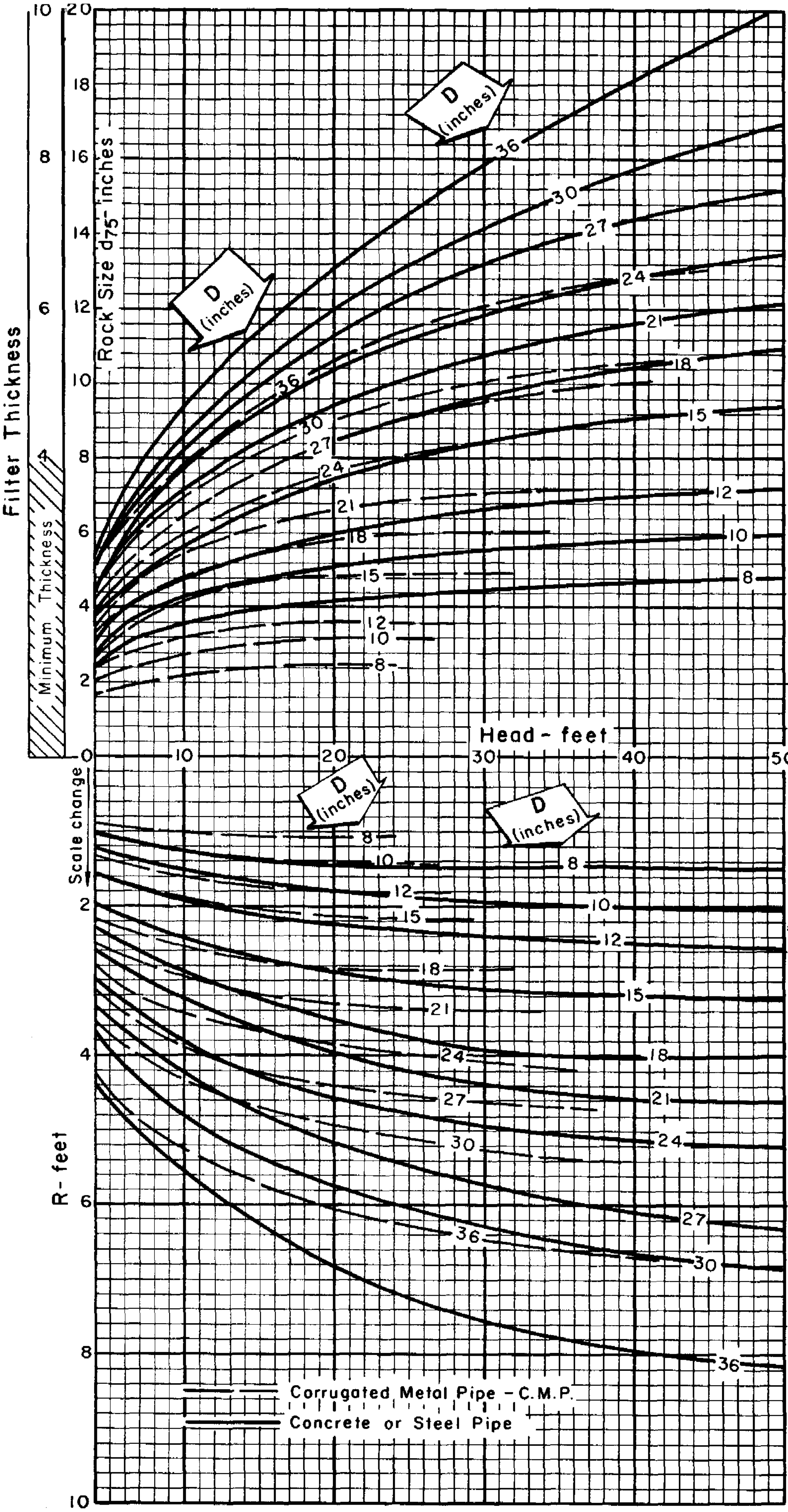
SIZE / ITEM	ALTERNATE TRASH RACK DIMENSIONS									
	A	B	C	D	E	*F	G	H	I	J
A	4'-0 3/8"	4'-0 3/8"	4'-6 3/4"	5'-1 1/8"	5'-7 3/8"	5'-7 3/8"	6'-8"	8'-3"	9'-3 5/8"	9'-10"
B	1'-10"	1'-10"	1'-10"	1'-10"	1'-10"	2'-10"	2'-10"	3'-10"	3'-10"	3'-10"
C	4"c-c	4"c-c	6"c-c	6"c-c	8"c-c	8"c-c	10"c-c	10"c-c	12"c-c	12"c-c

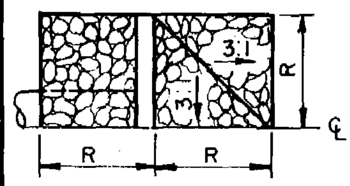
Example

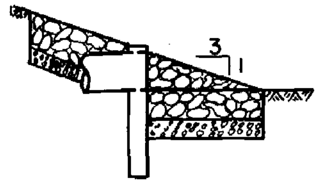
Given: Structure size G, head = 20'
Use one cross bar B

Find: From figure C-2 longitudinal member = $1\frac{1}{2}$" pipe
Cross bar B = $4 \times \frac{1}{2}$", length = 3'-0" − $\left[\frac{1}{2}" + 2(\frac{3}{8}")\right]$ = 2'-$10\frac{3}{4}$"
z = 4"
From figure C-3, A = 6'-8", B = 2'-10", and bar spacing = 10" c-c
Use separately removable longitudinal members

FIGURE C-3
ALTERNATE TRASH RACK
EWP Unit Portland, Oregon





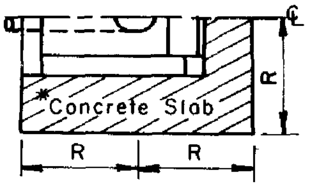


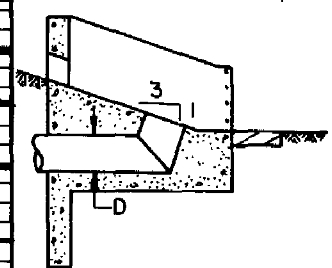
Thickness of rock riprap equals $1.5d_{75}$.

Thickness of filter equals $0.5d_{75}$ or 4" whichever is greater.

ROCK RIPRAP

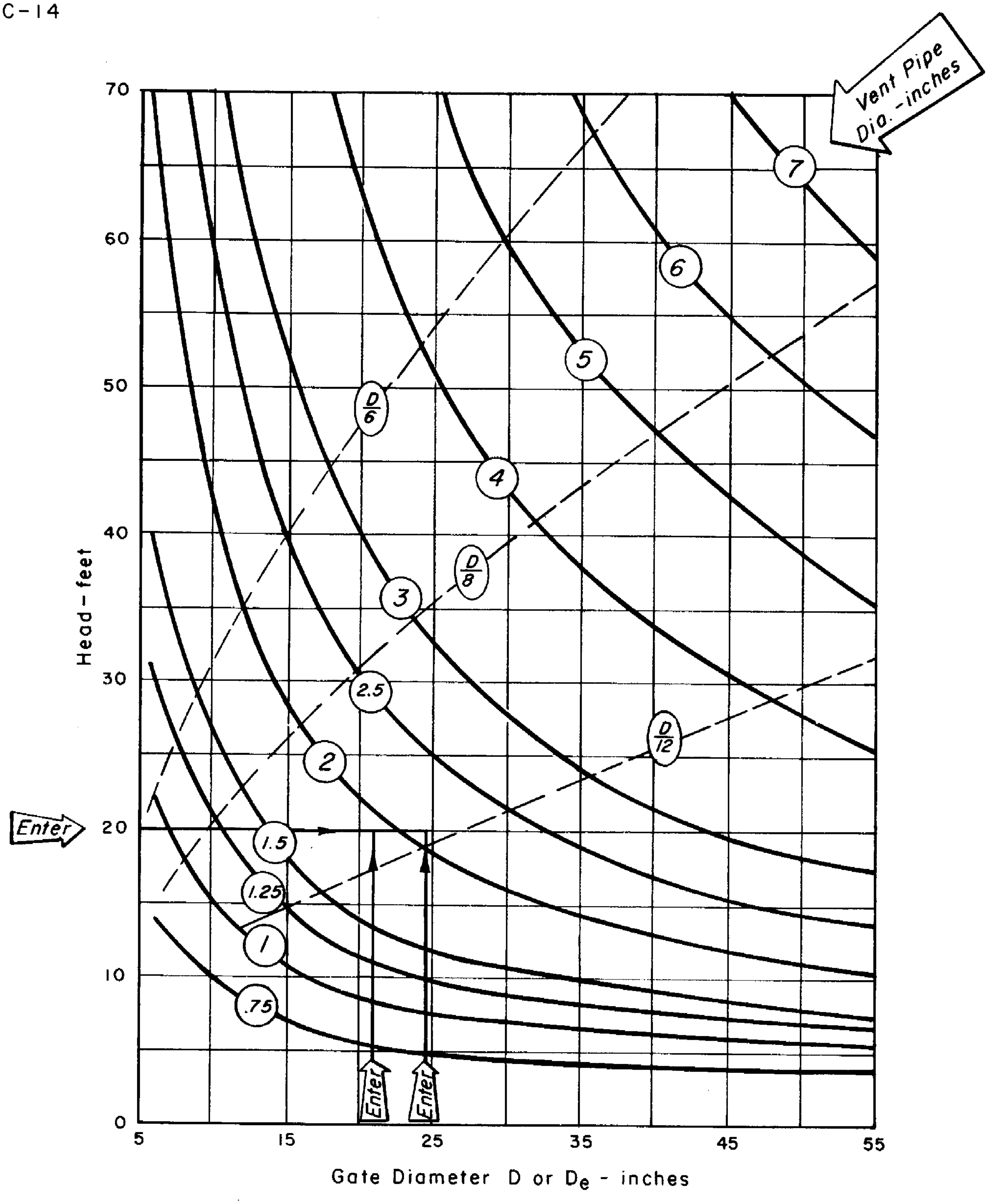
CONCRETE





*Rock riprap may be used in the shaded area instead of the concrete slab.

FIGURE C-4
INLET PROTECTION
EWP Unit Portland, Oregon



Note:

For rectangular gates enter chart with equivalent diameter (D_e)

$$D_e = 2\sqrt{\frac{bh}{\pi}}$$

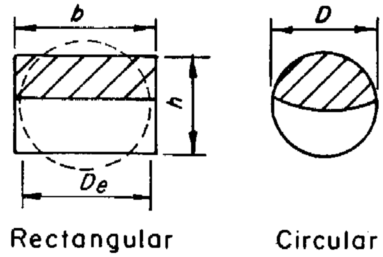


FIGURE C-5

VENT PIPE DIAMETER

EWP Unit Portland, Oregon